Fish Dietary and Tissue Residue Analysis (for analysis of risk to fish themselves)

Tissue Residue:

In order to use the tissue residue concentrations to assess risk in Portland Harbor an analysis of spatial scale is restricted by how the composites were put together. The composites average out variability in exposure, which would be normally reflected in the variability seen in individual tissue concentrations. The composites will always represent an average concentration, but this average may be more or less relevant depending on how close the compositing scheme came to representing the home range of the fish. Since we are interesting in protecting the fish themselves and not receptors feeding on the fish, understanding variability is important in protecting fish populations. Therefore, I would recommend the following analysis on the fish composites:

Data Available: Round 1 Tissue Composites for 8 species of fish ecological receptors including (number of composites indicated in parenthesis, including field replicates):

Juvenile Chinook (6)
Sculpin (26)
Largescale Sucker (6)
Carp (6)
Peamouth (4)
Smallmouth Bass (14)
Northern Pikeminnow (6)
Black Crappie (a HH fish receptor also looked at in the eco assessment) (4)
Brown Bullhead (a HH fish receptor also looked at in the eco assessment) (6)

1). Composite-by-composite screening of the tissue residue values should take place for each fish receptor, regardless of the estimated home range of the receptor. Maps should be developed to show area exceeding TRVs (based on area represented by each composite). The spatial scale evaluation (how much area is exceeding) is what was missing from the PRE evaluation, since only max values were used.

2). Statistical summaries can also be provided to compile the individual composite data for each species (e.g. maximum individual data value, range, mean, frequency of detection and frequency of exceedance of a PRG).

3). There may be a desire to average composites in order to estimate exposure concentrations feeding on fish (e.g. bald eagle, osprey). This evaluation is being covered in the wildlife section.

Dietary Analysis, PAHs and Metals:

The dietary approach is weaker in associations you can make between exposure and effects. Exposure is not measured, like in the tissue residue analysis, but estimated by an assumed dietary composition. The location (where the fish are feeding) and the composition (what are they feeding on) could range widely, leading to large uncertainties in estimating exposure. In addition, the TRVs literature to relate dietary effects to exposure is very limited at this time. However, a strong advantage of this approach is that we are not limited by how the composites were put together in estimating exposure concentrations. This analysis should evaluate the range of exposure each fish species could be exposed based on estimated dietary composition and habitat use. This approach was primarily proposed to assess metabolized or regulated contaminants such as PAHs and metals. However, the LWG has also proposed to look at PCBs and DDTs using this approach as well. I would recommend starting with PAHs and metals, and if we have time move on to the other contaminants – we will be evaluating these as a part of the tissue residue evaluation.

Data Available:

Sediment concentration data
Corbicula clam field, clam lab and *Lumbriculus* lab tissue residue concentrations
Multiplate tissue analysis

Approach:
Estimated sediment and prey concentrations for a range of areas could be calculated to see if estimated fish exposure areas exceed dose dietary TRVs.
Protective benchmark doses can be calculated at or below which impacts to species are not expected to occur. These doses are calculated by back-calculating prey or sediment concentrations that correspond to the benchmarks. These protective doses are then compared doses estimated from the prey and sediment in the environment.

*Note: For the dietary analysis we will need to re-calculate doses as directed in our comments on the PRE (as stated below). We need to ensure we have good dietary doses calculated, and move away from concentration based evaluations. The analysis presented below (for PAHs) presents a good start to this analysis, and we can even use their calculated protective benchmark doses as a starting point (0.014 to 0.196 mg/ total PAH/kg/day).

> ***Page 17, Section 4.1.2, Fish Dietary TRVs and Tables 4-3 and 4-4****: No extrapolation factors were applied to develop NOECs from LOECs. This is necessary for the use of the dietary approach. Specific protocol should be followed in the development of the dietary TRVs. Previous comments from EPA have emphasized the need to develop dose information for fish and not rely on concentration based TRVs. The concentration only comparison should be omitted and toxicity data from various toxicity endpoints should be converted to an exposure dose in mg/kg/day. This information can be compiled, and fit to a cumulative distribution function similar to what was done for the aquatic TRV development.*

The US Army Corps of Engineers, EPA Region 2 and Menzie-Cura (Driscoll, Stevens and Reiss) evaluated a number of PAH studies to develop dose-based toxicity benchmarks for exposure of fish to PAHs. In this example, a database of NOAELs and LOAELs was compiled consisting of PAH toxicity data. These included PAH toxicity data from 15 studies on 8 species, and included various life stages (larvae, fry, juvenile, adult), various compounds (e.g., benzo(a)pyrene, DMBA, fluoranthene, anthracene, and phenanthrene), various routes of exposure (water, diet, injection), various exposure durations (single injections, weeks, months), and various toxicity endpoints (hepatic lesions, growth, immunological, reproductive). Water concentrations were converted to an exposure metric (mg/kg/d) using the Arnot and Gobas equations (2004). The data was then fit to a cumulative distribution function, and the geometric mean of the NOAEL and LOAEL was calculated for each study to estimate NOAELs where they were not reported. The data were fit to a log-logistic cumulative distribution function, which was then used to estimate protective doses below which adverse effects in most fish are unlikely. This analysis developed benchmark doses of about ***0.014 to 0.196 mg/kg/day to represent dose levels that are protective of 90% to 99% of the population represented in the toxicity database, depending on the level of protection needed. Comparison of protection level doses to recent toxicity toxicity studies, which show reduced growth in fish at 0.035 to 0.5 mg total PAH/kg/day.*** *This range is below the selected PAH LOAEL TRV reported in Table 4-3 of 1.9 (mg/kg/d). The goal should be to develop dietary NOAELs for fish that are protective of all endpoints. The methodology outlined above may be applicable to Portland Harbor and could be carried forward to the other chemicals for which the dietary approach was used (e.g. Table 4-3 and 4-4).*

For tables 4-3 and 4-4 the final TRV selection was not clear. The selected concentration based TRVs differ from the dose TRVs. The concentration values should be converted to a dose and used in the TRV development.

Bold Text Added based on new revision to analysis, 2006.

Proposed Analysis (in order of priority):

1). As a first cut analysis, **calculate doses for benthic fish (sculpin, largescale sucker, carp, smallmouth bass, and brown bullhead) using the field collected clam locations and co-located sediment concentrations collected at the same time for each location.** Using only this sediment data for a first cut analysis has the advantage of being surface data (10 cm), and the most relevant for evaluating the benthic prey data. Although not all of these receptors feed on clams all the time, this tissue may be representative of other tissue that may occur at the site, and gives us a good look at the distribution for contaminants that are not as readily metabolized by benthic organisms such as clams (PAHs). This may be the best data we have to estimate dose to fish. By looking at the *Lumbriculus* and *Corbicula* data separately as calculated doses to fish we can evaluate patterns in the data we could not do otherwise once doses are mixed (e.g. 40% clam, 40% worm, 10% sculpin). For benthic fish, this analysis is also very relevant.

a). Field collected clam data (*Corbicula*) from 33 locations between RM 2 and 10 (sampling stations LW2-BT001 to LW2-BT033. Enough biomass (35 grams) was collected at 24 of the stations to allow for the analysis of the full suite of analytes. At nine stations a limited suite was analyzed for (at BT011, BT015, BT016, BT018, BT023, BT026, BT029, BT032, and BT033).

b). Surface sediment (top 10 cm) samples representing a co-located composite of the area from which clams were collected (same 33 locations).

2). **Calculate the same as above except use the *Lumbiculus* laboratory bioaccumulation data and co-located sediment data.** This data is from a 28-day laboratory test that, and therefore contaminants such as PAHs did not have time to reach steady state. Therefore, the concentrations measured in the bioaccumulation tests should be adjusted for steady state using the USEPA and US Army Corps of Engineers methodology (Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. – Testing Manual, Inland Testing Manual, 1998, EPA-823-B-98-004, Section 6.3).

a). *Lumbriculus* 28-day laboratory bioaccumulation test with the sediment collected in for 35 sediment samples (including replicate samples at BT006 and BT027).

b) Surface sediment (top 10 cm) samples representing a co-located composite of the area from which worms were collected (same 35 locations).

3). **BSAFs calculated using the co-located clam or *Lumbriculus* data should be used to estimate tissue concentrations at other locations not included in the clam / sediment sampling effort that may have differing PAH or metal concentrations. Additional sediment data could be used beyond the co-located mentioned above.**

4). After the site by site evaluation (using locations detailed above), the **clam and *Lumbriculus* empirical data can be averaged in order to evaluate effects on larger ranging benthic fish.** This evaluation could include averaging the empirical data as well as averaging using empirical and BSAF estimated data obtained from the BSAF analysis. This could be done to address risk to large scale sucker and sturgeon, and should include an average over the ISA divided into approximately 1/3 segments (RM 1.5 to 4.5, 4.5 to 7.5 and 7.5 to 10.5). For each segment each side of the river should be estimated separately and together to see if it makes a difference. These segments allow for an evaluation of a larger home range organism without losing the different characteristics of each reach. We can choose to average further if we wish, but doing this step first will give confidence that we aren't missing the "worst case average".

4). After the benthic prey evaluations, **add in crayfish and sculpin estimates for relevant fish species (just sculpin and smallmouth bass).** Use the estimates outlined in the LWG's Table 2 in the *LWG Response to EPA Framework Issue Summary*, dated August 24, 2006 for prey composition. Evaluate ranges of prey compositions to see if it makes HQs change significantly. This would be a small scale evaluation based on where sculpin and crayfish were collected. Some of these will line up with the clam and sediment collection. *Keep in mind that the dietary analysis is primarily used to support the risk analysis for metals and PAHs. As we add fish to the diet, these contaminants will be metabolized to a higher degree and the exposure point concentration may go down.

5). For pelagic fish, screen the multiplate data location by location using concentrations to estimate dose. We can add in other benthic tissue, and evaluate the dietary composition the LWG has proposed. We don't have a lot of good data to estimate dose for these organisms. Our dietary dose estimates will likely be off.

6). For predatory pelagic fish (northern pikeminnow) add in various estimates of fish ingestion based generally on the 1/3 segments mentioned above (RM 1.5 to 4.5, 4.5 to 7.5, and 7.5 to 10.5). Average the diet over these segments starting with the proposed dietary composition the LWG presented in Table 2. However, they present a large mix here (worms, clams, crayfish, scupin, sucker and pikeminnow). I would evaluate the diet first based on the worst case scenario consistent with its feeding habits – an all fish diet.